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TITLE

BATTERY POWERED ELECTRICAL EQUIPMENT WITH POWER SAVING OPERATION

FIELD OF THE INVENTION

This invention relates to electric equipment with power saving modes energized by a battery and more particularly, to portable electric equipment with batteries having power saving modes.

BACKGROUND OF THE INVENTION

In battery powered electrical equipment, remaining battery capacity can be detected and displayed to certify a term of energizing the equipment. There is other equipment in which an energy saving mode or usual mode can be selected to prolong the term of energizing the equipment. In this equipment, an operator has to operate some keys. Furthermore, it is necessary to operate some keys to insure a current energy saving mode. In this case, the displayed current energy saving mode has no relation to the displayed remaining battery capacity. That is why it is difficult to confirm that an appropriate energy saving mode is selected in accordance with the remaining battery capacity by the contents of displayed information.

Furthermore, while executing data processing in a normal energy saving mode, the equipment sometimes goes down and important data are lost as a result of loss of the battery power.

Even if the remaining battery capacity and the selected battery energy mode are displayed simultaneously, it is difficult for an operator to select an appropriate mode for desired operating time.

BRIEF SUMMARY OF THE INVENTION

The present invention has been made in consideration of the above situations, and has as one of its objects providing electric equipment capable of superimposing remaining operating time and the adopted power saving mode. Accordingly, the operator can easily understand how long the battery can supply power if the equipment operates in the current power saving mode and can select a desirable, power saving mode to provide adequate processing speed of the CPU and adequate brightness of the display unit.

It is another object of the present invention to provide electric equipment capable of displaying in close relationship the detected remaining battery capacity and the adopted power saving mode, so that the operator can easily understand how long the battery can supply power if the equipment works in the current power saving mode and can select the desirable and appropriate power saving mode to provide adequate processing speed of the CPU and adequate brightness of the display unit.

It is a further object of the present invention to provide electric equipment capable of indicating the detected remaining battery capacity and the adopted power saving mode. Therefore, the operator can easily

understand how long the battery can supply power and can select the desirable and appropriate power saving mode to control the processing speed of the CPU and the brightness of the display unit.

The invention will be better understood from the following more detailed description taken with the accompanying drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing construction of a portable electric equipment in the first embodiment;

Fig. 2 is a perspective view of the portable electric equipment;

Fig. 3 is a diagram showing construction of a display apparatus for displaying an energy saving condition;

Figs. 4A and 4B show a change of a time area in Fig. 3;

Fig. 5 is a block diagram showing construction of a control for electric equipment;

Fig. 6 is a block diagram showing construction of portable electric equipment in the second embodiment;

Fig. 7 is a perspective view of the portable electric equipment shown in Fig. 6;

Fig. 8 is a block diagram showing construction of a control of the portable electric equipment shown in Fig. 7;

Fig. 9 shows an example of a button and a display meter for saving energy; and

Fig. 10 is a block diagram showing a display data producing circuit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments according to the present invention will now be described with reference to the accompanying drawings.

(First Embodiment)

Fig. 1 is a block diagram showing construction of electric equipment in the first embodiment. The equipment is, for example, a personal (note book type) computer. In Fig. 1, numeral 101 denotes a power saving mode switch unit for selecting one of plural electric power saving modes. Numeral 102 denotes a power saving mode control unit for executing the mode selected by the power saving mode switch unit 101 on a personal computer unit 103. Numeral 104 denotes a remaining battery capacity detecting unit for detecting the remaining capacity of a battery 105. Numeral 106 denotes a remaining time arithmetic unit for estimating the time that the remaining battery capacity can be used in the power saving mode. Numeral 107 denotes a power saving condition display unit for displaying the time that the remaining battery capacity can be used in the power saving mode and furthermore a current mode which is selected by the power saving mode switch unit 101 is exhibited ~~superimposed~~ on the displayed time. a

As described above, the time that the remaining battery capacity can be used which is detected by the detecting unit 104 is estimated by the arithmetic unit 106 and ~~the estimated time and~~ the selected power saving mode a1 ~~are superimposed~~. Therefore, an operator recognizes the condition of the equipment and if the operator

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changes from one power saving mode to another mode, the power saving mode control unit 102 can control processing speed of the personal computer unit 103 and brightness of a display panel which is installed in a display unit housing 202 shown in Fig. 2.

Fig. 2 is a perspective view of a portable electric equipment. In Fig. 2, numeral 201 is a main body housing, 202 is a display unit housing which swivels on the main body. Numeral 203 denotes a knob for changing from one power saving mode to another power saving mode. Numeral 204 denotes a power saving condition display unit which includes a small liquid crystal panel mounted on the display unit housing 202. The power saving mode switch unit 101 in Fig. 1 corresponds to the knob 203 in Fig. 2 and the power saving condition display unit 107 in Fig. 1 corresponds ~~is correspond~~ to the power saving condition display unit 204.

Fig. 3 shows the construction of the display apparatus 204 as shown in Fig. 2 for displaying an energy saving condition. In Fig. 3, Numeral 301 denotes power saving modes. In this embodiment, numerals 1 to 6 ~~are~~ correspond to six power saving modes, the larger the numeral, the smaller the consumption of electric power.

Numerals 302, 303, 304 denote time areas. The display apparatus 204 as shown in Fig. 3 indicates that the remaining time is within thirty minutes in the modes 1 and 2. Furthermore, the display apparatus 204 as shown in Fig. 3 indicates the remaining time is about sixty minutes in the modes 3 and 4, and that the remaining time is more than two hours in modes 5 and 6. Numeral 306 (asterisk) shows that the mode 4 is currently selected.

Fig. 4 is a diagram showing a condition of a change of a time area illustrated in Fig. 3. In Fig. 4(a), the power saving condition display unit 204 shows that the battery is at almost full capacity. In this case, the area of 304 which shows the remaining time as about two hours is large. In Fig. 4(b), the power saving condition display unit 204 shows that the battery capacity is almost empty. In this case, the area of 302 which shows the remaining time as within thirty minutes is larger. As described above, it is easy for the operator to understand both the current selected mode and the remaining time in accordance with the remaining battery.

Fig. 5 is a block diagram showing a consumption control of the electric equipment. Construction and operation of the circuit block diagram will be described. A rotary switch 501 linked with the knob 203 shown in Fig. 2 grounds one of terminals 1 to 6. Each contact of contacts 1 to 6 is put at a high level returned to a voltage Vcc by a resistor RA and is connected to an encoder 502. Therefore, only the contact selected by the rotary switch 501 is at a low level and other five contacts are at the high level. The encoder 502 produces three bit data in accordance with the contact selected by the rotary switch 501. Thus, if the contact 1 is selected, the encoder 502 produces a (0, 0,1) code. If the contact 5 is selected, it produces a (1,1,0) code. And if the contact 3 is selected, the encoder 502 produçes a (0,1,1,) code. If the contact 4 is selected, it produces a (1,0,0) code.

In this embodiment, selecting one of the contacts corresponds to selecting one of power saving modes 1 to 6. The three data bits from the encoder 502 are transferred to a display data producing circuit 503. A display control circuit 505 decodes the three data bits

and produces display information for displaying the asterisk 306 at the predetermined position on the liquid crystal display unit 504. A display control circuit 505 drives the liquid crystal display 504 to display the data from the display data producing circuit 503. Therefore, one of the power saving modes 1 to 6 which is selected by the knob 203 is displayed on the liquid crystal display unit 504. On the other hand, the three data bits from the encoder 502 are transferred to a first decoder 506. The first decoder 506 produces two data bits which show rate divided clock frequency as described below. That is, if the three data bits from the encoder 502 are (0,0,1) or (0,1,0), the rate divided clock frequency is X. If the three data bits from the encoder 502 are (0,1,1), the rate of divided clock frequency is X/2. If the three data bits from the encoder 502 are (1,0,1) or (1,1,0), the divided clock frequency rate is X/4.

The two bit rate divided clock frequency from the first decoder 506 are transferred to a producing/dividing clock circuit 507. The producing/dividing clock circuit 507 produces a 20 MHz clock and transfers the divided clock to a CPU and a peripheral circuit 508 in accordance with the dividing rate from the first decoder 506. Namely, if the rate is X, the circuit 507 produces a 20 MHz clock, and if the rate is X/2, the circuit 507 produces a 10 MHz clock, and if the rate is X/4, the circuit 507 produces a 5 MHz clock.

Furthermore, the three data bits from the encoder 502 are transferred to the second decoder 509 which produces an electric current to drive an invertor 512 as described below. That is, if the three data bits from the encoder 502 are (0,0,1), a digital value of the electric current for driving the invertor 512 is (1,1), thus, a back light quantity of the display 504

is 3W (3 watts). If the three data bits from the encoder 502 are (0,1,0), (0,1,1) or (1,0,1), the digital current value is (1,0), and the back light quantity is 2W (2 watts). If the three data bits from the encoder 502 are (1,0,0) or (1,1,0), the digital current value is (0,1) and the back light quantity is ~~W~~ 1W (1watt).

The two bit electric current data from the second decoder 509 is transferred to a second converter 510. The converter 510 produces an analog electric current for driving the invertor 512 which supplies a voltage to the back light 511 that may be, for example, a cold-cathode tube.

As described above, by operating the knob 203, the working frequency of the CPU unit 508 in the personal computer unit 103 as shown in Fig. 1 changes between 20 MHz, 10 MHz and 5 MHz, and light quantity of the blacklight 511 changes between 3W, 2W and ~~W~~ 1W. The working condition in the power saving mode 1 to 6 are set as follows. The CPU working frequency is 20 MHz and the light quantity of the blacklight is 3W in the power saving mode 1. The CPU working frequency is 20 MHz and the light quantity of the blacklight is 2W in power saving mode 2. The working frequency is 10 MHz and the back light quantity is 2W in the power saving mode 3. The working frequency is 10 MHz and the back light power saving quantity is ~~W~~ 1W in the power saving mode 4. The working frequency is 5 MHz and the back light quantity is 2W in the mode 5. The working frequency is 5 MHz and the back light quantity is W in the power saving mode 6. Therefore, the higher the working frequency of the CPU 508 is, the higher is the processing speed and the larger is the electric consumption. The lower the working frequency of the CPU 508 is, the lower is the processing speed and smaller is the electric consumption. Moreover, the

larger the back light quantity is, the larger is the electric consumption. Less back light quantity reduces the electric consumption. Therefore, the power saving mode 1 has a highest processing speed and consumes the most electric power. The power saving mode 6 has the lowest processing speed and consumes the least electric power.

In Fig. 5, a terminal voltage of a battery which drives the equipment is transferred to an A/D converter 514 and the A/D converter 514 produces an eight bit digital code which is transferred to a remaining battery capacity arithmetic circuit 515. The remaining of battery capacity arithmetic circuit 515 calculates the remaining battery capacity in accordance with the digital value of the terminal voltage of the battery 513. A remaining time arithmetic circuit 516 calculates remaining time of battery in every mode in accordance with the result of the remaining of battery arithmetic circuit 515. The remaining time is (1) less than thirty minutes, (2) about one hour, (3) more than two hours. These remaining times correspond to the power saving modes 1 to 6. Data indicating the correspondence between each mode and the remaining of time is transferred to a display data producing circuit 503 and the shaded data shown in Fig. 3 are produced. Furthermore, combination data which includes the shaded data and the asterisk are transferred to the display control circuit 505. As a result, the power saving mode which is selected by the knob 203 and the data which shows the remaining time are displayed on the liquid crystal display unit 504.

Fig. 10 shows the display data producing circuit 503 of Fig. 5 in greater detail. Numeral 1 in Fig. 10 denotes a one chip CPU that includes input output ports P1 and P2, data output lines D0 through D7 from an output D ~~C~~ of

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